Many formulæ in common use are of, or can be transformed to, the general type—

$$u = k\, x^a\, y^b \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (8)$$

where u, x, y are variables, and a, b, k are constants, positive or negative. These can be represented by an alignment diagram in which there are three parallel straight lines (one for each variable), and the scales of which are logarithmic—*i.e.*, like those on a slide-rule. Since it is a property of a logarithmic scale that the lengths representing each multiple of 10 are equal—*e.g.*, the distance from 1 to 10 is equal to the distance from 10 to 100—and so on, each of such lengths constitutes a logarithmic unit.

Let N_u, N_x, N_y represent the length of the logarithmic units in terms of any standard length for each of the variables u, x, y, and let these units be called positive when the scales increase upwards, and negative when they increase downwards. Also let B_{ux} B_{xy} be the distances between the axes, as shown in Fig. 3 (Plate 2).

It will be assumed that the units and positions of the x- and y-scales are selected so as to cover the required range of values and to form a compact diagram; two or three trials will probably be necessary before this is achieved. The values of N_x, N_y, and B_{xy} are therefore known, and it is required to determine N_u and B_{ux} to complete the diagram.

Then the rules for construction are—

(I.) For the logarithmic unit of the u-axis—

$$\frac{l}{N_u} = \frac{a}{N_x} + \frac{b}{N_y} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (9)$$

(II.) For the position of the u-axis relatively to the x- and y-axes—

$$B_{ux} = \frac{N_u}{N_y}\, b\, B_{xy} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (10)$$

If B_{ux} is positive, the u-axis lies towards the y-axis; if it is negative, the u-axis lies away from the y-axis.

(III.) For the position of the u-scale on its axis, assume values of x and y in equation (8), and calculate u. Place the u-scale in such a position on its axis that the calculated value is intersected by the index line laid through the assumed values of x and y on their respective scales.

The method may be extended to equations containing four variables of the type—

$$u = x_a\, y^b\, z^c \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (11)$$

where z and c are an additional variable and constant respectively. This may be written—

$$u = k\, x^a\, v \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (12)$$

where—

$$v = y^b\, z^c \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (13)$$

Equations (12) and (13) are evidently of the same form as equation (8), and can be regarded as two tri-axial alignment diagrams with a common v-axis. When, therefore, in equation (11) the values of any three, say, u, x, y, of the four variables are given, that of the fourth, z, is determined by drawing two index lines, one through x and u, intersecting the common axis at v, the other through v and y, intersecting the z-axis at the required value, as indicated in Fig. 4 (Plate 2). On the same principle the diagram may be extended to formulæ containing more than four variables.

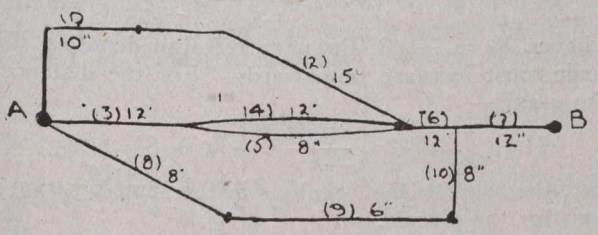

FIG. 2.

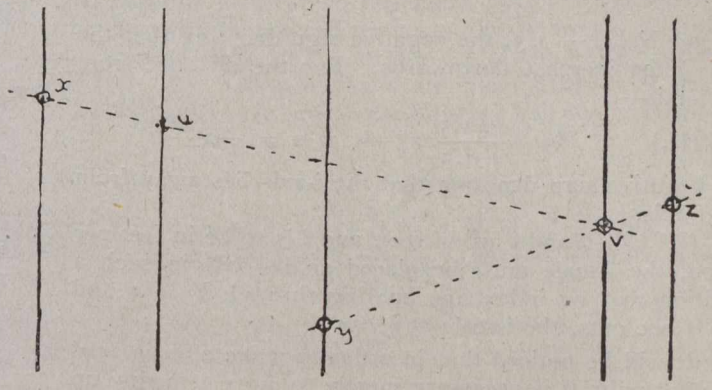

FIG. 4.

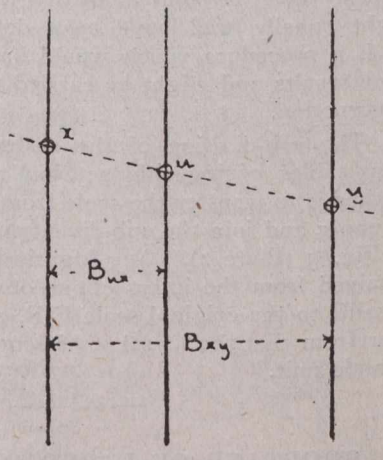

FIG. 3.

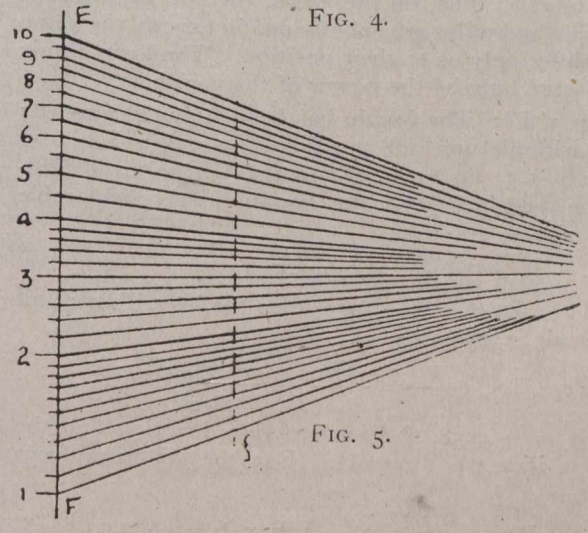

FIG. 5.

Plate II.—Alignment Diagrams for Water Mains.